

Field-scale Assessment of Phytotechnologies at Sites Impacted with Weathered Hydrocarbons

Year 4 Overview

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Rationale . . .

- 🌍 Phytotechnologies have the potential to play an important role in future remediation strategies in Canada
- 🌍 A **critical need** for 'field performance data' to verify this potential, as well as to assess its limitations and determine appropriate uses of the newly emerging phytotechnologies (*Environment Canada - Environmental Biotechnology Applications Division*)

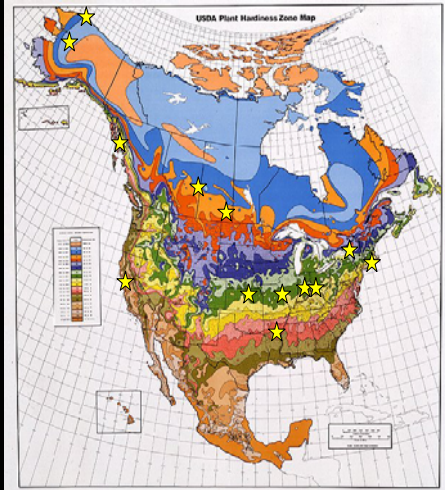
Rationale . . .

- 🌍 To fully exploit and use phytotechnologies we need to gain a better understanding of
 - ◆ the pool of phytoremediation species found in Canada
 - ◆ how phytoremediation operates under unique Canadian climatic conditions
 - ◆ the mechanisms employed by phytoremediator plants to restore contaminated sites
 - ◆ the agronomic requirements needed to optimize phytoremediation as an efficient and cost-effective cleanup technology

Project Objective

- 🌍 Establish field research sites in SK and AB to assess and demonstrate the utility of phytoremediation as a means of reducing PHC levels in oil-impacted soils to environmentally acceptable endpoints
 - ◆ maintain and monitor these sites for a minimum of three years,
 - ◆ conduct plant assessments and hydrocarbon analyses at the end of each growing season
 - ◆ assess the effectiveness of fertilizer/amendment treatment and plants as a means of reducing TPH concentrations in the contaminated soils
 - ◆ prepare final report assessing the success of the project, including an economic analysis of the costs associated with phytoremediation

Field Assessments (RTDF)



Standard experimental protocol

- ◆ (<http://rtdf.org/public/phyto/protocol/protocol99.htm>)
- ◆ RCBD with 4 treatments replicated 4 times
- ◆ 3 growing seasons
- ◆ 2 sampling depths
- ◆ Analyses include
TPH & PHC-fractions (CCME), PAHs, biomarkers
plant assessments
microbial diversity

Canadian RTDF Sites

Site L

- ◆ Southeast SK
- ◆ Mixed grassland/parkland
- ◆ Dark Brown to Black Chernozem
- ◆ Heavy clay loam

- ◆ Buried flare pit
- ◆ ca. 2400 m³
- ◆ ca. 5,500 ppm TPH
- ◆ EC ≈ 6 mS cm⁻¹
- ◆ SAR = 25

Site M

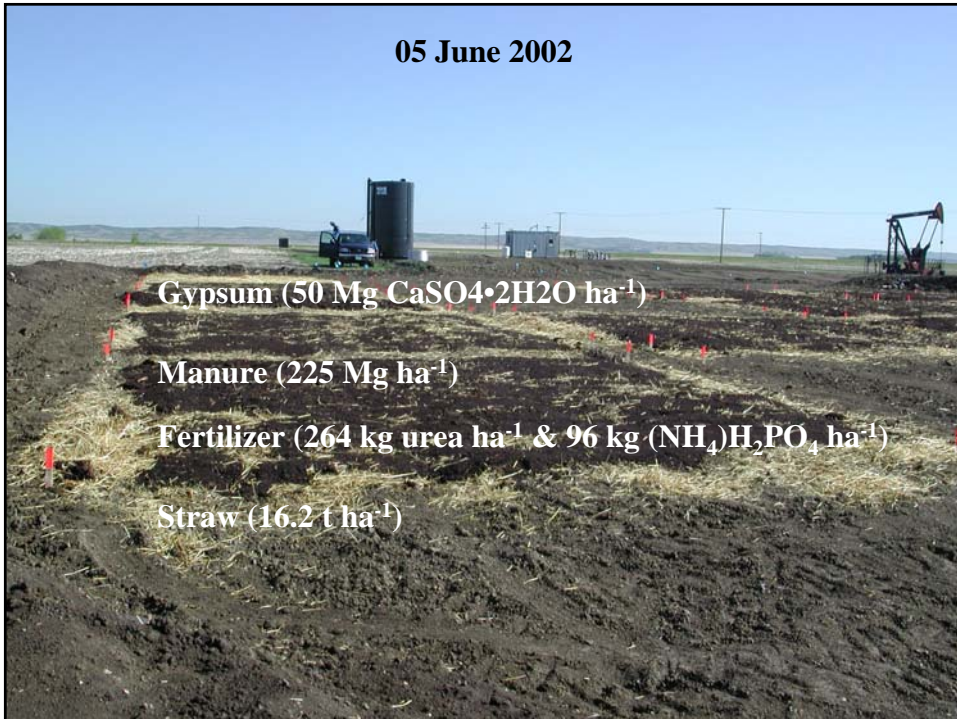
- ◆ East Central AB
- ◆ Boreal fringe
- ◆ Black Chernozem to Gray Luvisol
- ◆ Sandy clay loam

- ◆ Tank farm soil
- ◆ ca. 1200 m³
- ◆ ca. 3,050 ppm TPH

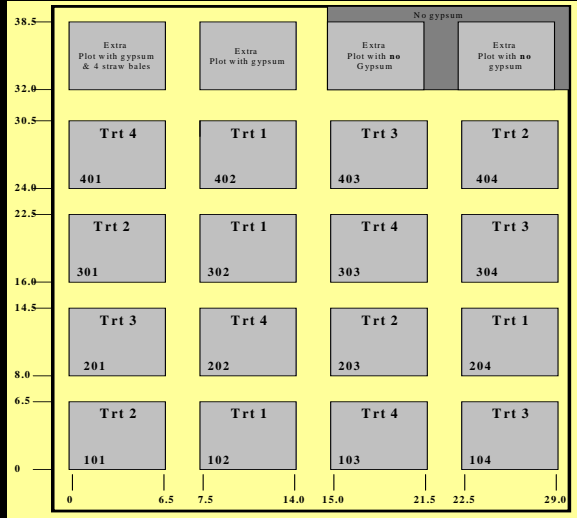
**Saskatchewan RTDF Site
Flare Pit Excavation (30-10-01)**



05 June 2002



Site L: Plot diagram



Trt 1: unfertilized (gypsum), unplanted

Trt 2: fertilized, unplanted

Trt 3: fertilized, planted (RTDF mix)

Creeping red fescue (60%)

Yellow sweet clover (25%)

Perennial ryegrass (15%)

Trt 4: fertilized, planted (U of S mix)

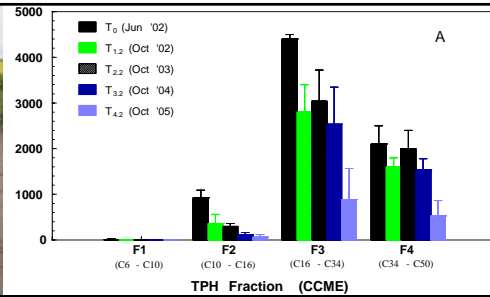
Tall wheatgrass (28%)

Nuttall's salt-meadow grass (28%)

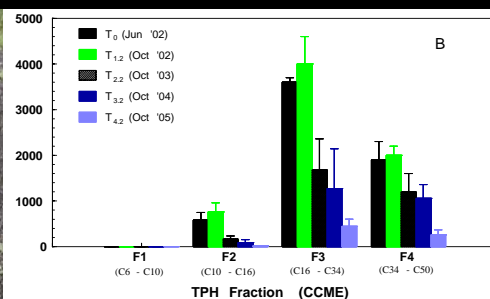
Altai wild rye (28%)

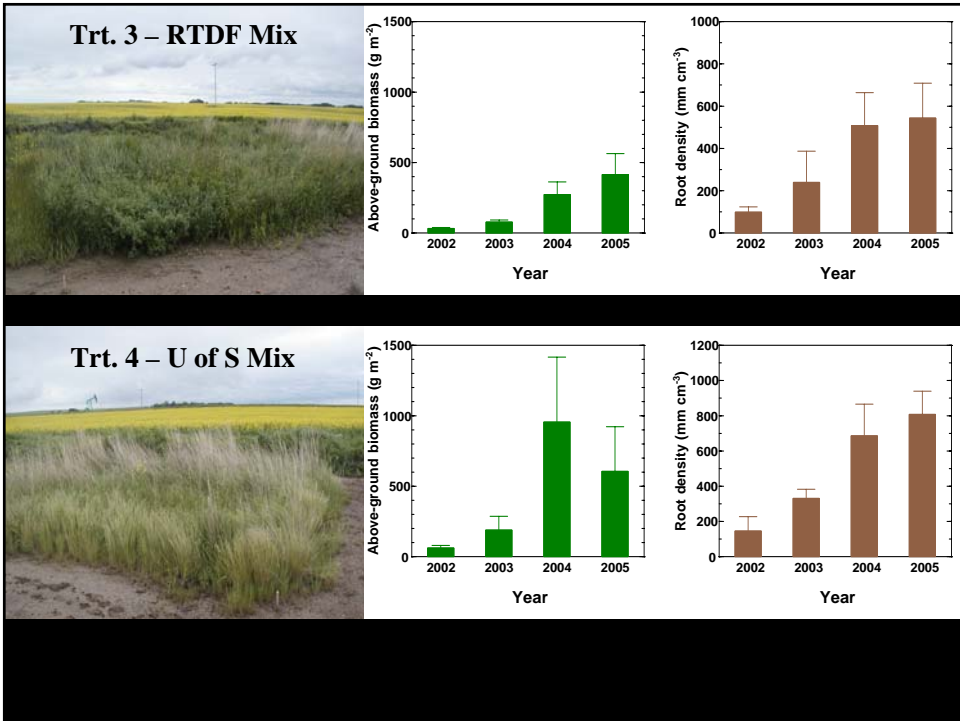
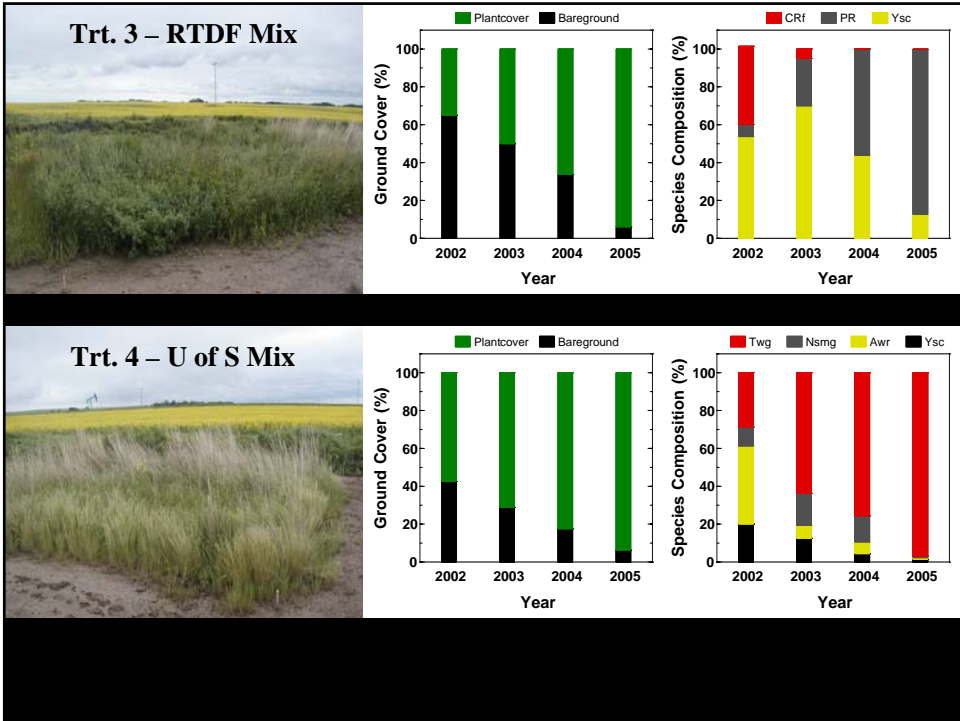
Yellow sweet clover (16%)

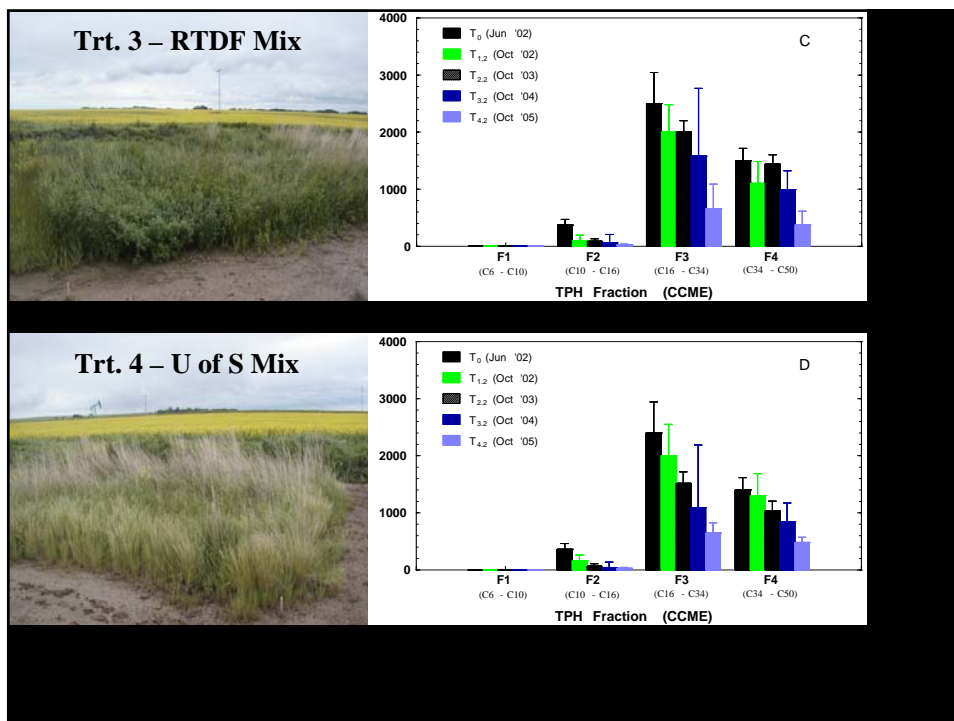
Trt. 1 – unfertilized control



Trt. 2 – fertilized control







Canadian RTDF Sites

Site L

- ◆ Mixed grassland/parkland
- ◆ Southeast SK
- ◆ Dark Brown to Black Chernozem
- ◆ Heavy clay loam

- ◆ Buried flare pit
- ◆ ca. 2400 m³
- ◆ ca. 5,500 ppm TPH
- ◆ EC ≈ 6 mS cm⁻¹
- ◆ SAR = 25

Site M

- ◆ Boreal fringe
- ◆ East Central AB
- ◆ Black Chernozem to Gray Luvisol
- ◆ Sandy clay loam

- ◆ Tank farm soil
- ◆ ca. 1200 m³
- ◆ ca. 2,050 ppm TPH

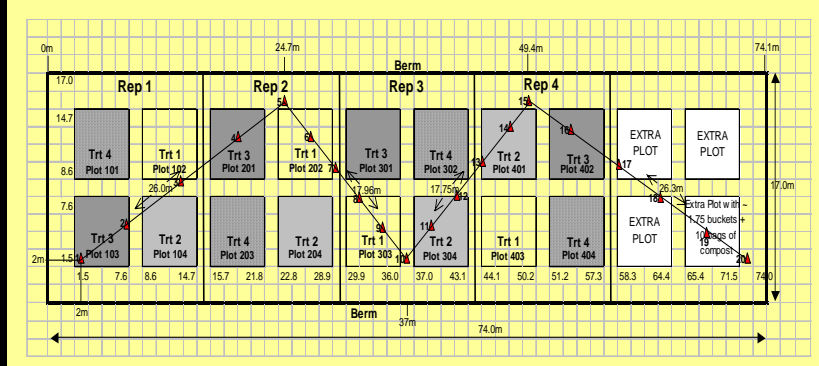
**Bruderheim RTDF Site
Excavation (30-11-02)**



Bruderheim RTDF Site – May 28/02



Site M: plot diagram

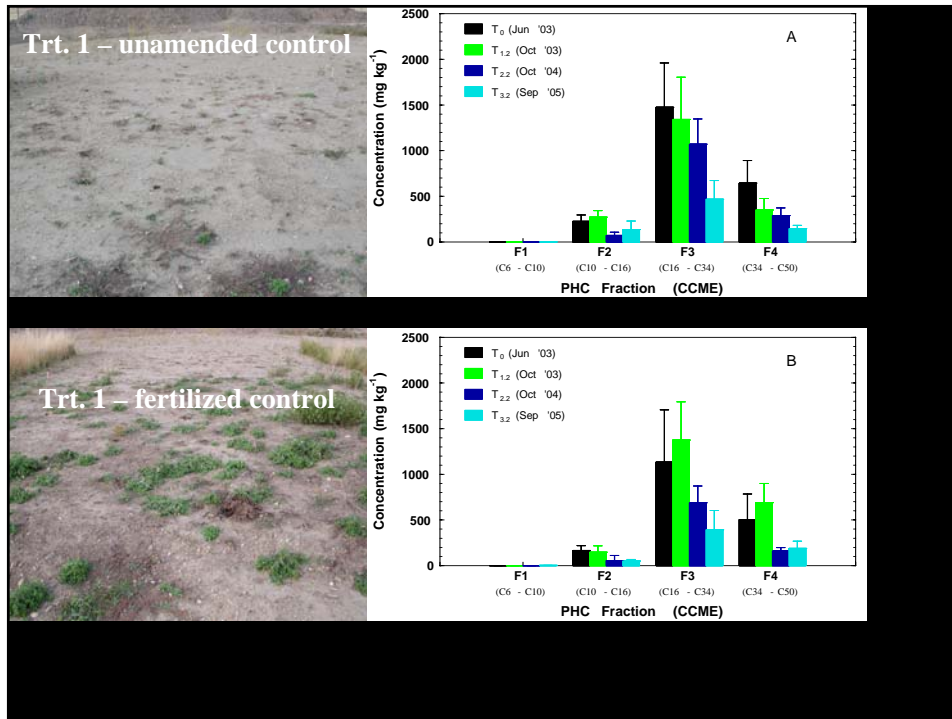


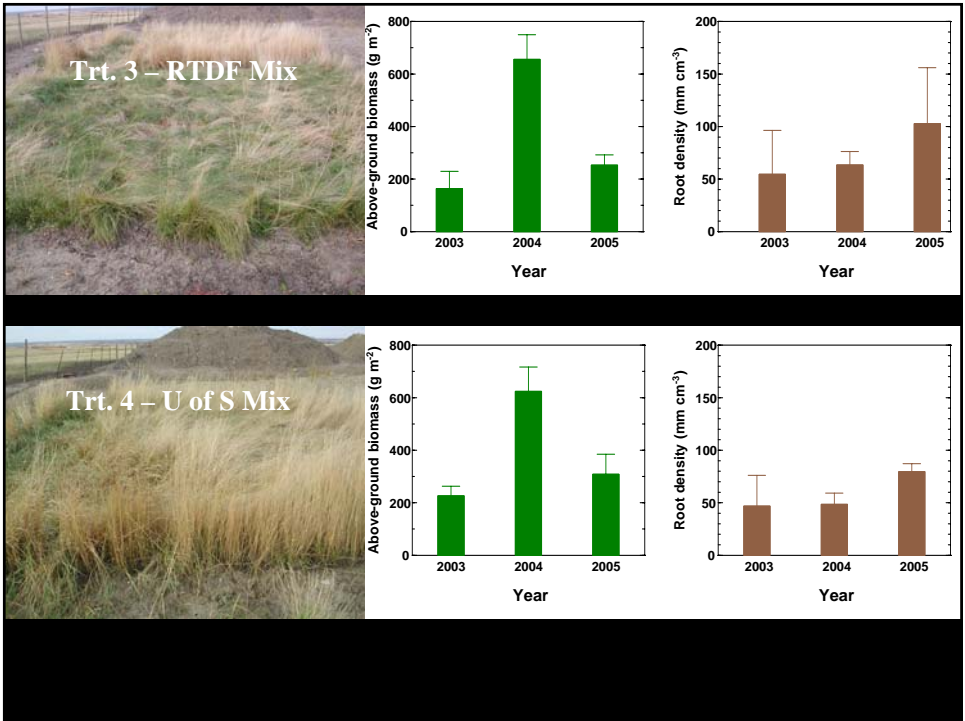
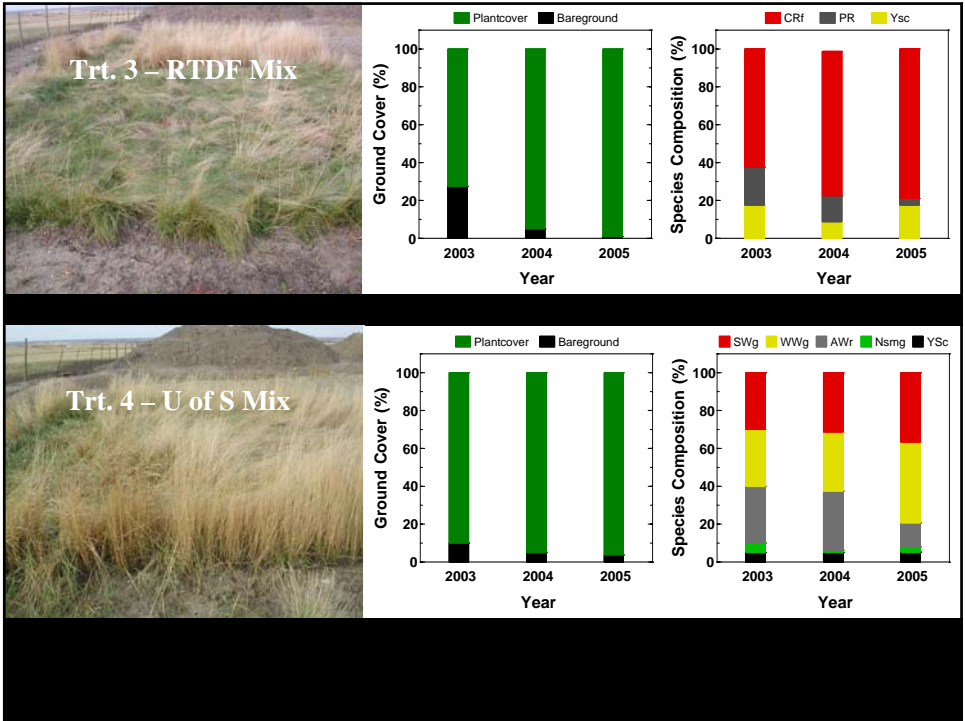
Trt 1: unfertilized, unplanted

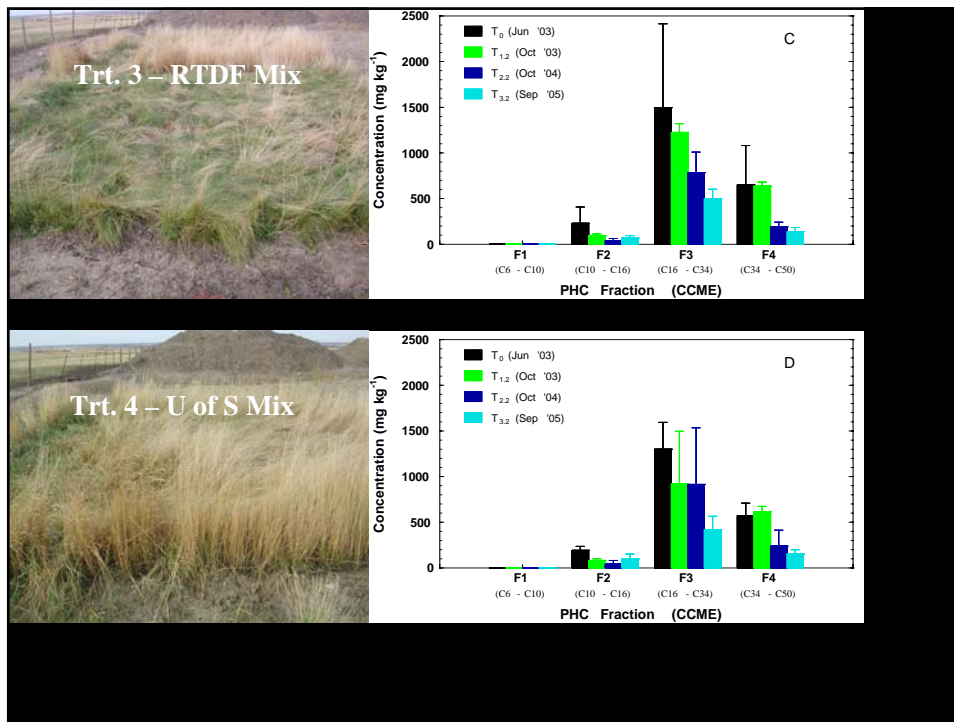
Trt 2: fertilized, unplanted

Trt 3: fertilized, planted (RTDF mix): Creeping red fescue (60%); Yellow sweet clover (25%); Perennial rygrass (15%)

Trt 4: fertilized, planted (U of S mix): Slender Wheatgrass (20%); Tall wheatgrass (20%); Altai wild rye (20%); Red clover (20%); Nuttall's salt-meadow grass (20%)







What we can say so far . . .

- 🌐 Significant reductions in PHC concentration at both sites.
 - ◆ whereas reductions in PHC concentration were reflected in all four CCME PHC-fractions, they were most pronounced in the F2 (equivalent C-numbers C10–C16) and F3 (equivalent C-numbers C16–C34) fractions.
- 🌐 PHC concentrations at both sites were characterized by highly skewed frequency distributions (spatial variability).
 - ◆ high degree of variability tended to obscure treatment differences.
- 🌐 Reductions in PHC concentrations in the planted plots and unplanted plots were generally similar, though reductions in the F2 (C6–C10) and F3 (C16–C34) fractions generally occurred more rapidly in the planted treatments.
- 🌐 Reductions in PHC concentrations were generally greater in the plots amended with fertilizer and compost.
 - ◆ there were no significant differences between the site-specific plant mix and the standard (RTDF) plant mix.

University of Saskatchewan Phytoremediation Research Team

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Natural Sciences and Engineering Research Council (NSERC)
Saskatchewan Agriculture & Food
Environment Canada
Program for Energy Research & Development (PERD)
Canadian Association of Petroleum Producers (CAPP)

Talisman Energy
Husky Energy, Inc.
Federated Co-Operatives, Ltd.
USEPA-RTDF